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Item 7 (a) of the provisional agenda*

Reports on achievements in surveying, mapping and charting in addressing national, subregional, regional and global issues, including policy and institutional issues

Cooperation in the Baltic and Barents regions in joint database projects**

Paper submitted by Finland

Summary

The regions of the Baltic Sea and the Barents are, and in the future will be even more so, important transnational areas in Europe. Geographic information provides new opportunities for these regions and will be advantageous for all activities that require different kinds of information to be put together. A sustainable development requires a basis of mutual knowledge and understanding between the people of the region.

The mission of the Baltic and Barents projects (MapBSR and the Geographic IT within the Barents region, both in scale 1:1 million) is to bridge the gap between areas or regions, which are shared or affected by several countries, yet must be managed as a whole. For these transnational areas and situations it is essential to build shared spatial databases of known quality. From these experiences the Association of the European National Mapping Agencies, EuroGeographics (formerly Comité Européene des *Responsables* de la Cartographie Officielle (CERCO)), has initiated the idea of creating a European data set in the scale of 1:1 million, the "EuroGlobalMap", which aims at being the European contribution to the Global Mapping initiative.

Digital map of the Baltic Sea region (MapBSR)

Initially driven by the needs of environmental assessment in the Baltic Sea region, the MapBSR database now covers 13 countries partly or in full. The origin of the MapBSR is the Vision and Strategies around the Baltic Sea (VASAB) 2010 project, which was initiated in 1992 by the Baltic Region Ministers of Physical Planning. At the conference held in Karlskrona, Sweden, it was stated that a coordinated map data system should be created covering the entire Baltic Sea region with basic geographic information.

The participants of the MapBSR project are the National Mapping Agencies of the countries around the Baltic Sea. The National Mapping Agencies of each of the participating countries have produced data regarding their own area. The national data has been combined into one database by the MapBSR project coordinator, National Land Survey of Finland. The MapBSR project has received funding from the European Union INTER-REG II C programme.

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The database has data from the countries around the Baltic Sea. Totally covered are Finland, Sweden, Denmark, Poland, Latvia, Lithuania, Estonia and Belarus. The administrative units from Germany, Czech Republic, Slovak Republic, Ukraine and the Russian Federation that intersect the Baltic Sea drainage area are included in the database.

The MapBSR database is digital, uniform map database for the Baltic Sea region in the scale of 1:1 million. The elements included in the database are administrative boundaries, hydrography, transport, settlements, geographical names, elevation and nature. The database can serve as a base map for geographic information systems (GIS), in which any kind of data item can be located and presented as long as its coordinates are known. The MapBSR database can be used by private individuals, organizations and government authorities for a wide variety of purposes (for example spatial planning and transnational cooperation).

The MapBSR database can be obtained in vector data in Arc/Info format on CD-ROM. The coordinate system is geographical coordinates in decimal degrees (longitude and latitude). The reference system is WGS84 (EUREF89) with ellipsoid WGS84. Database will be updated regularly. The product MapBSR 2000 is now available on CD-ROM (www.mapbsr.nls.fi).

Geographic information technology within the Barents region

In 1993, an international agreement was signed between Norway, Sweden, Finland, Denmark, Iceland, Russia and the European Union to develop cooperation for economic growth and sustainable development in the Barents region. The agreed cooperation is implemented through action plans such as the Barents Programme and the Interregional Programme of the European Union. In the work to prepare the action plans, a clear need for a common base map and other geographical descriptions were identified.

During the period from 1998 to 2000 the first step of the "Geographic Information Technology (IT) within the Barents Region" has been executed through a cooperation project between the Mapping Agencies in Norway, Sweden, Finland and Russia and the Regional Committees for Land Resources and Surveying in Murmansk and Arkhangelsk *oblast* and the Republic of Karelia in Russia. This project includes several activities regarding competence development, establishment of digital databases and printed maps, statistical data, atlas, data communication and so forth.

The project has developed a common standard for the homogenous geographic database, produced data in accordance with the common standard in a scale of 1:1M and made the database available for the different users in the region. Furthermore, modern geographic information technology has been introduced in the Russian Federation and producers and users have been trained in the use of the modern technology. A map series has been printed in the scale of 1:1,000,000.

The immediate beneficiaries, and also the most important reference organizations of the project, are the Russian and Nordic regional governments and especially the professionals at the Committees for Land Resources and Land Surveying of Karelia and of the Murmansk and Arkhangelsk regions in Russia, where they have increased their productivity through improved competence, work practices and the use of hardware and software. The same impact has also been achieved, but to a smaller extent, in all units of the National Mapping Agencies that have taken part in the project.

The secondary beneficiaries are the other public sector authorities and enterprises throughout the whole Barents region and in the participating countries that will be given access to the Barents Geographic Data Base. The ultimate beneficiaries are the people living in the Barents region, who will, in the long term, receive improved services from both the public authorities and private enterprises dealing with planning, land management, marketing studies, environment, renewable energy resources, emergency services, health care, political analysis and many other areas of use.

The second and final phase of the project "Geographic IT within the Barents Region" aims at establishing of an Internet-based infrastructure for joint use of geographic and thematic data in the Barents region. This will be achieved through cooperation between the National Mapping Agencies and their local branches in the region, which will include institutional development, capacity- and competence-building and exchange of expert knowledge. The thematic and other databases will be coordinated according to the already established standard for the whole region and made available for use by the authorities and the general

public in the region. Further information can be obtained from: www.nls.fi/org/inter/barents_git.

European contribution to the Global Map Database

The Association of the European National Mapping Agencies, EuroGeographics, covers today some 36 countries. As a major building block of the European Regional Spatial Data Infrastructure (RSDI), it celebrated its twentieth anniversary in 2000. The Association's 20 years are marked by many concrete achievements, such as pan-European data sets and information services.

The success of the Digital Map of the Baltic Sea Region (MapBSR) and the actual increasing demand for a seamless European data set led to considering the extension of the concept to the whole of Europe. The feasibility of this extension was addressed in a study that assessed the data availability, the technical issues involved and the economical and financial implications of creating such a product. As learned from the questionnaire included in the feasibility study, most of the European National Mapping Agencies see the benefit of creating a seamless database covering all of Europe.

At the time that the MapBSR project evolved in the Baltic Sea region, the Global Mapping initiative also approached the European National Mapping Agencies by asking for cooperation in creating a global database in scale 1:1 million. Global Map defines itself as a group of global geographic data sets of known and verified quality, with consistent specifications, which will be open to the public, considered a common asset of mankind and distributed worldwide at marginal cost. More information on Global Mapping can be found at: www1.gsi-mc.go.jp/isegm-sec/index.html.

As response to this Global Mapping approach, the European National Mapping Agencies have together decided to build their own regional component of the Global Map, "the EuroGlobalMap". The reason for that decision is that the European Agencies found it important to create a seamless database for the region, not just a puzzle of data from separate countries. The Project Agreement to start the *EuroGlobalMap*-project by the Association of the European National Mapping Agencies is aimed to be signed at the beginning of 2001. The Project management of this project is entrusted to the National Land Survey of Finland.

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Item 7 (b) of the provisional agenda*

Reports on achievements in surveying, mapping and charting in addressing national, subregional, regional and global issues, including technical issues

Project Cartosur I

Submitted by Venezuela**

1. Introduction

The *Instituto Geográfico de Venezuela Simón Bolívar* (the national mapping agency of Venezuela) has undertaken the mapping of the vast region between the Orinoco River and the Brazilian border. This remote region of Venezuela has a warm and humid climate, with almost permanent cloud cover. The topography is hilly, with few flat areas and very abrupt elevations emerging from the plain. The land is mostly covered by rainforest, with trees reaching 40 metres in height. The project consisted in producing 5 metre pixel digital orthoimages and orthoimage maps at 1:50,000 scale, with 40 meter contours derived from a digital elevation model over a region of 266,616 square kilometres. The total number of map sheets covering the area is 536.

The *Institut Cartogràfic de Catalunya* (Cartographic Institute of Catalonia) submitted a technical proposal based on interferometric synthetic aperture radar (SAR) technology to ensure that products would be obtained and delivered in a predictable period of time, regardless of the weather conditions and abundant cloud cover. The accuracy and pixel size specifications excluded the use of satellite radar and, therefore, the AeS-1 single pass airborne interferometric radar from AeroSensing Radarsysteme, GmbH (Wessling, Germany) was proposed and selected for the project. After a preliminary ground survey campaign and the preparation of the logistics, the flight mission began on 20 October 1998 and it ended successfully on 5 February 1999. During the whole year 1999 the radar data set has been processed and all the maps have been produced.

2. The AeS-1 radar

The AeS-1 interferometric SAR from AeroSensing Radarsysteme (Moreira, 1996) is an advanced radar operating in the X-band that is capable of delivering radar images with pixel sizes ranging from 0.5 to 5.0 metres and elevation data with nominal accuracy of 5 to 50 centimetres. The radar emits and receives the signals using two antennas that are rigidly mounted on one side of the airplane and 0.59 metres apart, so as to form the baseline of the interferometric geometry. The radar illuminates the terrain laterally at an angle ranging from 20 degrees (near range) to 67 degrees (far range). Due to the separation of the

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ntennas, the range to a point is slightly different as measured by each antenna; this range difference corresponds to a phase difference from which the elevation is determined. The motion of the airplane affects the phase of a point, so this motion has to be recorded and compensated. The current configuration uses global positioning system (GPS) and inftared navigational system (INS) data from an Applanix system to determine the effects induced by the motion of the aircraft and to obtain the orientation of the sensor. In addition, the aircraft had to follow the flight lines with almost no deviations (less than 20 metres). Therefore, the flight navigation system makes use of digital global positioning system (DGPS) data transmitted from a reference station. The transmitter's maximum range is 300 kilometres and its location was carefully chosen so as to always have visibility to the aircraft. This was achieved by computing a digital terrain model (DTM) from the contour lines of existing 1:500,000 scale maps and by performing a visibility analysis. GPS data at the reference stations was recorded for post-processing.

3. Mission preparation

The project area was divided into strips 130 kilometres long and 14 kilometres wide, and flown at 26,000 feet. Depending on the terrain type, flat, hilly or mountainous, the side overlap was 50 per cent, 67 per cent and 75 per cent, in order to guarantee that enough images would avoid the shadowing and layover effects. Consecutive tracks were flown in opposite directions. The airfields were selected from the few available in the area. The selection criterion was suitability for flight operations: availability of supplies, accessibility and minimization of ferries. The selected airfields were Puerto Ayacucho, La Esmeralda and Santa Elena de Uairen. Fuel and food were carried by river and by air. The AeS-1 system relies on GPS and INS data for georeferencing, so ground control is used for checking purposes only. The checkpoints can be made visible on the radar image by installing radar reflectors (corner reflectors) at known positions. Therefore, a survey campaign was performed together with the Geodetic Department of the National Mapping Agency of Venezuela to measure 31 positions where the corner reflector would be installed. None was installed at that time, due to the risk of being displaced, destroyed or even covered by the vegetation.

4. Flight campaign

Before starting the mission, AeroSensing flew a calibration flight, in order to ensure the absence of any systematic error and to measure different parameters, for example, the corner reflector shape and width in the image, a precise measurement of the baseline, radiometric parameters for compensating the different radiometry in the far and near range parts of the swath, and the effective number of *looks* required to maintain a low enough noise level. For this project the number of *looks* was set to 7.

4.1 Data capture

As mentioned earlier, the installation of the corner reflectors was performed simultaneously with the flight. Two reflectors were installed with two different orientations, so that they could be imaged on two opposite tracks. Some had to be installed on top of the "tepuys" and required the use of a helicopter to transport the people, the reflectors and the GPS equipment. The flight campaign lasted from 28 October 1998 to 3 February 1999, including repairs, mandatory revision of the airplane, re-flights, change of airfields, etc. There were 67 effective flying days, with around 10 tracks per day. While cloud cover does not affect the radar images, dense clouds with high water content and turbulence do prevent operations, since they directly affect the quality of the image.

4.2 On-site quality control

After landing, the on-board disks were removed and the contents copied to DLT 7000 tapes. On-site quality control followed, in order to detect any anomaly: – Radar checking: analysis of parameters such as raw signal variations, power variations, etc., in order to ensure that the radar had operated correctly during data acquisition. – Movements of the aircraft: attitude variations of less than 3° in roll, 1° in pitch and 2° in heading, and variations of less than 30 metres in height and 100 metres in position. – Image quality: a 0.8 x 14 km. segment of each track was fully processed and checked if the control was passed, a copy of the DLT was sent to the *Institut Cartogràfic de Catalunya (ICC) (Barcelona)*. The quality control detected some bad tracks, which were re-flown immediately. The amount of data collected was around 16 Tb.

5. Product generation

The AeS-1 software runs on a network of standard personal computers (PCs). The software is predominantly written in IDL and runs on Linux Operative System.

5.1 SAR processing

The hardware configuration at ICC consists of five processing lines, each with two DLT drives and 13 slave PCs connected to the Ethernet. At each string the DLT containing a 130 kilometre long track is read, divided into segments of 0.5 gigabytes with 25 per cent longitudinal overlap and distributed among the slave PCs. Each segment takes up to 6.5 hours to process on a standard Pentium II 450 MHz microprocessor with 256Mb RAM and 9 Gb disk. On average, a track is processed every 32.5 hours. The combined throughput of the five strings is a track every 6.5 hours. A central PC with a FoxPro DB dispatches jobs to every processing line and takes care of the archival and data management. The first step in processing consists of the reconstruction of the two complex images (intensity and phase) from the raw data signal of the two antennas. The aircraft motion is corrected at this stage. The two complex images are then co-registered for computing the interferogram on a pixel-to-pixel basis. The interferogram is then obtained by multiplying the first image with the complex conjugate of the second. The interferogram represents the phase difference due to the elevation of the terrain and is expressed ("wrapped") modulo 2. The "phase unwrapping" process computes the absolute phase difference by adding 2 if discontinuities of 2 are detected in the interferogram. The AeroSensing method for phase unwrapping is a hybrid least squares combined with region growing algorithm. All these processes are automatic and involve long computations in the Fourier space. The output is an image coded in slant range and an unwrapped phase interferogram.

5.2 Geocoding

The phase unwrapping process can fail for several reasons. That is to say, there are discontinuities that are not well resolved, as in the case of the layovers and shadows, and terrain returning low signal (i.e. rivers). These errors must be removed by editing the phase manually. The elevations are then computed from the absolute phase after phase calibration. Two methods can be used: the first takes the elevation of a corner reflector and assigns it to the corresponding phase at this point (the phase becomes "calibrated"). The second method is iterative and is based on the interferograms of the contiguous tracks covering the same area from opposite sides. The process iterates until a solution that minimizes the differences in elevation is found. This method is very time-consuming but it does not require any ground control or operator interaction.

Once the elevations are known, tracks are geocorrected and assembled together in a mosaicking process. As mentioned earlier, the SAR processing part runs in batch and can be managed by one operator. However, the geocoding requires manual intervention. A group of 12 operators with two supervisors and a project leader operate the configuration at ICC.

5.3 Radiometric corrections

Because the side-looking geometry, the radar images are brighter at the nearest side and darker at the far range. A similar effect occurs with the relief: slopes oriented to the radar beam are brighter. Since a map sheet is formed by mosaicking consecutive opposite tracks, a radiometric compensation process is applied to equalize the radiometry.

5.4 Digital terrain model

Interferometric techniques provide a very dense grid of elevations. It should be noted that since each pixel has a phase associated, each pixel has a height. Thus one finally gains a very dense 5 by 5 metre elevation grid covering the 266,616 square kilometres. Each elevation is a single precision floating point value of the top of the features - in other words, the result of the interferometric process is a very dense digital surface model (DSM).

The DSM is first filtered in conflict areas, such as the zones near the rivers, and in areas that are void due to specular reflections and shadowing effects. An almost cloud-free Landsat coverage is used for estimating the height of the trees and converting the DSM into the Digital Terrain Model (DTM). After co-registering with the radar images, the Landsat scenes are classified using unsupervised clustering techniques. Height differences between adjacent classes are obtained by drawing profiles across them and then extracting the heights from the DSM. The output is a table with the average differences in height for each

type of transition between classes. The bare soil class is used as a reference, and then the heights are subtracted from the DSM to obtain the DTM. The classes are derived from the texture of the radar images in places where the Landsat scenes are covered by clouds. Interpolating from the neighbouring heights eliminates local minima and maxima. Contour lines are then computed automatically, and very small closed contours are deleted.

5.5 Map finishing and editing

Geographical names have been extracted from existing maps and placed on the map. Finally, frames, legends and marginalia are placed on the map, plotted on film and printed.

6. Quality control

The radiometric control of the digital images consists of a both qualitative and a quantitative evaluation (Lira, 1999). The qualitative evaluation relies on a visual inspection and checks for defocusing, global contrasts, noise, existing artefacts and visual discrimination of small textures. The quantitative tests check for the real number of *looks*, the radiometric resolution, spatial resolution, contents of the *speckle* associated with the radar images, etc. The geometric control of the digital products is made using the ground control point measurements done during the field campaign. The points have been observed on the images and a comparison with the ground measurements has been done. Due to the poor image coherence near the water bodies a few points has been rejected but final result shows a very good geometric confidence. The planimetric test using 24 points shows a circular RMS error of 8.8 metres. The altimetric test using 31 points shows an RMS error of 5.7.

7. Conclusions

The most important conclusion is that single pass airborne interferometry is a reliable and operational tool for mapping missions in areas with severe cloud cover. Having become accustomed to the long stand-by of photographic missions in this type of area, the performance of the radar flights is a very pleasant surprise, even though some days can be lost due to excessively dense cloud cover or turbulence.

On the other hand, a long period of time is required to process the radar data. This is due not only to the considerable computations, but also to the trial-and-error type of process mentioned earlier. Comparatively, the amount of hardware needed and time spent are several times greater than for an equivalent optical mission. Fortunately, the intensive computer-bound processes run in batch on a configuration that is easily scalable.

References

Lira, J. (1999). *Calidad de una imagen radar*. Personal communication.

Moreira, J. (1996). Airborne SAR: image generation and height precision DEM generation. In *International Archives of Photogrammetry and Remote Sensing*. Vienna, Austria, vol. XXXI, part B2, Commission II, 256-260.

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Statement by the President of the Simon Bolivar Geographical Institute of Venezuela: Institutional Aspects

Report submitted by Venezuela**

With the recent passage of the National Geography, Mapping and Land Registry Act promulgated by the President of the Republic on 28 July 2000 (see Official Gazette No. 37.002), the Simon Bolivar Geographical Institute of Venezuela was established under the Ministry of the Environment and Natural Resources.

The regulations pertaining to geography and mapping contained in the Act have filled a gap in our legal system. Although those intersectoral and ongoing functions are one of the foundations for the State's other activities, until now there was no body of rules defining and giving legal effect to the methods and procedures through which the State achieves its objectives.

In matters pertaining to land registration, the Act unifies, updates and strengthens the existing regulations which had been scattered in various Acts — rural land registration in the Vacant and Common Lands Act (1936) and the Agrarian Reform Act (1960), urban land registration in the Organic Law on the Municipal Regime. This separation made it difficult to carry out a complete and definitive land registration programme. The activities carried out by the competent bodies were isolated and resulted in a preliminary or initial land registry and there was no possibility of arriving at a clear title, since the relationship between the physical aspects of the land registry and the Public Registry had not been legally established. The National Geography, Mapping and Land Registration Act solves this problem.

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The legal instrument will allow the Government, among other things, to: know the extent of its territorial assets; execute agricultural, industrial and housing development plans in an orderly manner and with full legal certainty; recognize and protect collectively owned lands of indigenous peoples; and provide legal certainty for both public and private property. As the governing body with national jurisdiction, the Simon Bolivar Geographical Institute of Venezuela will be responsible for setting policy and designing plans and programmes to promote the formation of a high-quality geospatial information system, in order to make available, at all times, up-to-date knowledge about the country's geography.

With regard to the establishment and maintenance of the national land registry, close coordination will be maintained with the municipalities; the latter will conduct that activity following guidelines and technical standards established by the Institute.

Completion of mapping in the south, establishment of a national geospatial database, a national land registry system, a national remote sensing centre and participation in the demarcation of indigenous lands are some of the goals which the new Simon Bolivar Geographical Institute of Venezuela is aiming to achieve.